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THE POWERLINE COMMUNICATION-BASED COMPUTER NETWORKING IS THE SOLUTION FOR COMPUTER NETWORK INSTALLATION

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ABSTRACT - **The installation of computer network sometimes faced many problems. By adding new wires across the buildings or rooms, it is possible to look scattered. The power wiring can easily found in every buildings or rooms. The data signal streams can be carried by electrical wave on the power wiring. Powerline Communication (PLC) is the data communication technology using power wiring / powerline as its medium. Powerline Communication uses Orthogonal Frequency Division Multiplexing (OFDM) as its modulation scheme. By using OFDM modulation scheme, it is hoped that the performance of Powerline Communication will appear the current technology using UTP cables. The installation of computer network can use the preinstalled medium by passed it on the power wiring, so it doesn't require high investation, and added wires acrossing our buildings or rooms. This paper also shows dependable experiment result about Powerline Communication-based computer network transfer rate performance. Based on this fact, the installation of powerline communication-based computer network is very easy, because the infrastructure is already available. The installation of Powerline Communication-based computer network just require PLC Adapter, the power wiring and the power outlet should have been already available in every part of our buildings or homes.**

Keyword : power wiring, computer network, powerline communication, PLC Adapter, OFDM.

I. INTRODUCTION

Internet Access and data transfer between computer have being important needs for people. Unfortunately, the installation of computer network and internet access network faced many problems. The budget needed for expanding internet access network is very high. The lack of the budget is the reason.

The internet data signal stream can be carried on power wiring. Powerline Communication (PLC) is the data communication technology using power wiring / powerline as its medium.

The powerline / power wiring constitutes a rather hostile medium for data transmission. The inconsiderable noise, and high attenuation are the main issues[2]. Some technique is needed to solve these problems.

Powerline Communication uses Orthogonal Frequency Division Multiplexing (OFDM) as its modulation scheme. OFDM modulation scheme used in Powerline Communication technology due to its special ability, such as immunity to powerline interference, high spectral efficiency, efficient implementation using FFT, and robust handling of large delay spreads and frequency selective channels[1].

By using OFDM modulation scheme, it is hoped that the performance of Powerline Communication will appear the current technology using UTP cables. The installation of computer network can use the preinstalled medium by passed it on the power wiring, so it doesn't require high investation, and added wires acrossing our buildings or rooms, because the power wiring can easily found in every buildings or rooms.

By research about powerline communication-based computer network, it is hoped that the effort to widen the computer network and internet access can takes faster time and requires less budget.

II. BASIC THEORY

2.1 Computer Network Concept

The simple definition about computer network is, two or more computer that physically connected by a medium, and there is an interaction between them. There something that a system should have in order to being a network, they are :

a. The things that can be used together. It can be software or hardware.
b. The physical connection between computers. In order to have being interaction, a computer should be connected with some medium that able to transfer the data.
c. The rules in inter-computer communication. In communication, a system should have some rules that can be accepted with another system in one network, so the data sent by sender

computer can be accepted by the receiver computer properly. This rule is called protocol.

The purpose in computer network is not only sharing the common resources (hardware, likes printer) or to broadcast the data, but also understanding other entity, and using the data received from other entity in the network.

Based on the coverage, computer network is classified in 3 types, they are :

1. *Local Area Network* (LAN)

Local Area Network (LAN) is the private network in the building or small area. LAN is being used to connect private computers and workstation in order to use the common resources, like printer, together, and to exchange information.

2. *Metropolitan Area Network* (MAN)

Metropolitan Area Network (MAN), is the larger LAN, and usually uses the same technology with LAN. Its coverage is about some kilometers.

3. *Wide Area Network* (WAN)

Wide Area Network (WAN) is the data communication network that its coverage is cover a country or maybe a continent.

2.1.1 Data Transfer Medium

A computer requires some medium to connect with others computer in order to communicate and interact in a network computer. The computer can communicate using cable, ray, and radio frequency medium. The medium designate for data transmission, and not being a translator of the data. The data transfer medium explained in this paper only UTP Cables, and Powerline Communication.

2.1.1.1 UTP Cables

In UTP Cable, there is no protector for main cables pair. Fig 1 show pairs of cables colored to distinguish.

Figure 1. UTP Cable

Category 5 UTP Cable consist of 4 pairs of twisted cable and has bandwidth up to 100 Mbps, while the Category 5E ones up to 1Gbps. This cable is usually being used in Fast Ethernet (100Base). The connector used by UTP Cable is **RG-45**.

2.1.1.2 Powerline Communication (PLC)[1,4,5]

The principles of Powerline Communication is using high frequency that not being used for transmitting electricity. The electricity transmitting usually uses 50-60 Hz frequency. PLC uses the higher frequency to transmit data.

PLC uses OFDM (*Orthogonal Frequency Division Multiplexing)* modulating scheme to transmit data. The principle of OFDM is dividing spectrum into low-speed lower spectrum. The frequency uses to transmit is about 4,5-21 MHz.

The powerline / power wiring constitutes a rather hostile medium for data transmission. The inconsiderable noise, and high attenuation are the main issues[2].

2.1.2 Inter-Network Connection Medium

The inter-network connection medium is functioned to connect small independent network component with another network component. In *Internetwork*, the networks are logically divided, but still physically connected.

2.1.2.1 Modem

Modem works by converting digital signal into analog signal that will be transmitted to other computer / entity via cable. Modem can be connected with inter-network component likes router.

2.1.2.2 Hub

Hub being used as main component to connect many computers in one network. Hub work with broadcast method, so each port will receive all sent signal. Hub passes the signal from connected port to all ports in the hub. Hub is also functioned as signal amplifier. With this method, the network coverage can enlarge.

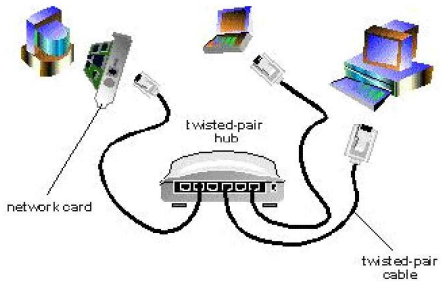

Figure 2. Hub for inter-computer connection.

2.1.2.3 Switch

As Hub, Switch is main component to connect many computers in one network. The different with Hub is, Switch pass the signal or data packet to the destination port, while hub pass it to all port.

2.1.2.4 Homeplug PLC Adapter

PLC Adapter is used to convert analog data stream from UTP Cable to powerline. The homeplug PLC Adapter on stores available in two kind of transfer rate, 85 Mbps, and 200 Mbps. Theoretically, the first one mostly appear Category 5 UTP Cable maximum transfer rate.

Figure 3. Aztech HL105E Homeplug PLC Adapter used in experiment.

2.1.3 Protocol Ethernet (IEEE 802.3)[7]

Ethernet is cabling and signal processing protocol for computer network data transmitting. Ethernet system standardization has been done by IEEE since 1978. Ethernet Protocol is also known as IEEE 802.3. Now, Ethernet data transmitting speed is about 10Mbps up to 10 Gbps.

Ethernet is CSMA/CD (*Carrier Sense Multiple Access with Collision Detection*) method implementation. In CSMA/CD, a computer host which sends data to the network will ensure that the network is not being used by other computer. If in the checking phase, another data transmission found and the collision happened, so the computer host should re-request the transmission in the next time. These mechanisms proceed in microseconds. So, the network can be used effectively.

To identify a computer host, in all Ethernet device is given 48-bits unique address. This address is known as MAC Address (Media Access Control Address). The information of the address is saved in chip, and will be shown in 16-based number or hexadecimal number.

2.2 OFDM Modulation Scheme [1,3,6]

OFDM is the modulation technique implemented to the modulated signal. It is divide data paralelly, then, in each subchannel is modulated with orthogonal subcarrier. And then, it will transmitted simultaneously. OFDM probably send high-speed data stream by dividing it into low-speed data stream.

OFDM modulation scheme used in Powerline Communication technology due to its immunity to powerline interference, high spectral efficiency, efficient implementation using FFT, and robust handling of large delay spreads and frequency selective channels[1].

These advantages are needed to solve the channel transmission condition that passed in power wiring, that can easily becomes different, and has high noise. OFDM also has disadvantages such as, sensitive to Doppler shift, sensitive to frequency synchronization problems, requiring more expensive transmitter circuitry, and giving poor power efficiency.

OFDM is multicarrier modulation technique. The main principe of OFDM is dividing high-speed data into low-speed data stream. And then will be transmitted simultaneously with orthogonal subcarrier. The orthogonal is, when the result of the multiply of two signals deterministic, is zero. It is expressed as (1).

$$\frac{1}{T}\int_0^T (e^{j2\pi k_1 t/T}) * (e^{j2\pi k_1 t/T}) dt = 0 \quad (1)^{[4]}$$

where (*) denotes the complex conjugate operator.

OFDM signal consist of many subcarrier, and then will be modulated using some mapped scheme like PSK (Phase Shift Keying) or QAM (Quadrature Amplitude Multiplexing). And the result will be transformed into OFDM symbols in IFFT. In IFFT, the orthogonal carrier wave is generated.

III. HOMEPLUG PLC ADAPTER INSTALLATION

The way to use Powerline Communication-based computer networking is very easy. The requirement hardware in PLC-based computer networking is almost the same with conventional computer networking. Just need at least 2 desktop computers / laptops having RG-45 slot, and at least 2 Homeplug PLC Adapter included UTP Cable, and network component such as router or switch connected to internet, if we want to connect the computer network to the internet access.

If we didn't use network component such as router or switch connected to internet, the computer network just functioned as Local Area Network (LAN). Make sure that your computer ables to comunicate with other computer, by setting it on the Control Panel.

If one of the homeplug PLC Adapter connected to the internet, so the Installation in home-indoor will expand the internet network in every part of the home by passed it on power wiring, if the power wiring installation is installed in the same electricity phase.

IV. RESULT

My experiment show that the maximal Transfer Rate from Powerline Communication-based Computer Network is 3,1 MBps, (24,8 Mbps) that measured using shareware application, Bandwidth Meter version 4.0.0. The Homeplug PLC Adapter used is Aztech HL105E, which have 85Mbps transfer rate. On the other hand, the maximal Transfer Rate from Conventional Computer Network (using Category 5E UTP

Cable) is 19,5 MBps, (156 Mbps) that measured using the same application.

The powerline / power wiring constitutes a rather hostile medium for data transmission, they were not designated for data transmission. The inconsiderable noise, and high attenuation are the problems faced. Some technique is needed to solve these problems. Because of the complicated technique needed to solve these problems, so it caused lower rate PLC-based experiment result.

The testing experiment done in some PLC-based computer network topology shown below.

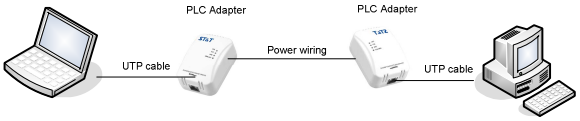

Figure 4. Peer-to-peer PLC-based topology, with several distance and file size variable.

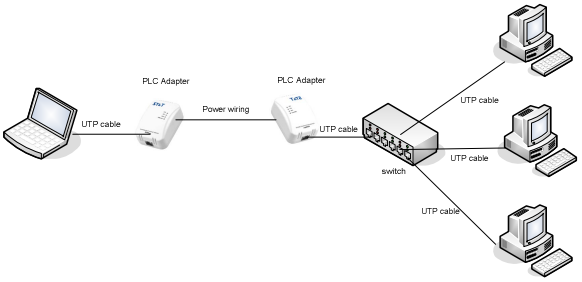

Figure 5. One-to-many PLC-based topology, with several distance and file size variable.

The internet access ability is can easily done, as Conventional Computer Networking using UTP Cable.

One thing should be noticed is, the performance of data transfer rate may vary. The determining factor are the distance and the file size.

As longer the distance, as lower the transfer rate. In the other hand, as bigger the file size, it is possible to reach as higher the transfer rate.

V. CONCLUSION

Different hardware specification can determine the transfer rate performance. It is easier to use the Powerline Communication-based computer network to access the internet than to transfer file between 2 computers. The Powerline Communication coverage is very limited, about 300 meters maximum [5], in the similar electricity phase. The data communication using Powerline Communication offers worse performance and worse stability than UTP Cable does, because the power wiring was not built for communication purposes. As a result the transmission capabilities are restricted, resulting to severe bandwidth constraint, and high level noise [2]. Although Conventional computer networking using UTP Cable offers better reliability, however Powerline Communication-based computer networking offers easier installation. The Powerline Communication-based computer network is suitable for low-speed home networking. Further research is needed to increase the transfer rate and better stability.

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